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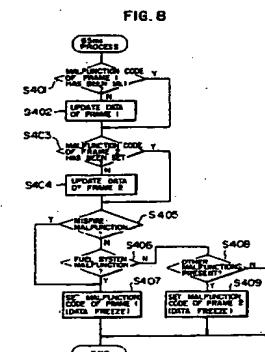
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㉕ **SELF-DIAGNOSING APPARATUS OF VEHICLE.**

㉖ A self-diagnosing apparatus of a vehicle, which can reliably hold and store diagnostic data relating to major troubles. A control unit (1) includes a CPU (101) and a RAM (102) that keeps the data if the ignition switch is turned off. The self-diagnosing apparatus detects a plurality of troubles, which are classified into major ones and minor ones. The RAM (102) includes a plurality of memory regions comprising a frame (1) and frame (2), and these frames (1) and (2) are corresponding to major and minor troubles, respectively. The CPU (101) processes diagnostic data of each part of the vehicle necessary for analyzing troubles of instruments and updates the memory contents of individual regions of the frames (1) and (2). If a trouble with an instrument is detected, the CPU (101) sets a trouble code to the leading region of the frame corresponding to that trouble, and inhibits subsequent updating of the

memory content. Accordingly, the diagnostic data can be stored and held depending on the classification of trouble.



## Technical Field

The present invention relates to a self-diagnosing apparatus for motor vehicles which stores diagnostic data necessary for analyzing malfunctions of instruments installed in such motor vehicle.

## Background Art

At the present time the construction of motor vehicles has become remarkably electronic. Instruments, including, among other things, the engine, installed in each section of a motor vehicle are interconnected to each other via a control computer so that complex operations can be performed.

In such case, even if a malfunction of a certain single installed instrument is detected, often the true cause for the malfunction, including the interrelation with other installed instruments, cannot be determined unless a wide range of data (diagnostic data) indicating the state of the motor vehicle at the time the malfunction is detected is collected. Also, after a temporary malfunction, there is a possibility that the malfunction will be corrected naturally. Further, often this is a sign that a complete failure will occur; however, it is quite difficult to find the cause thereof by performing an inspection after getting out of the motor vehicle.

Accordingly, a self-diagnosing apparatus is disclosed in Japanese Patent Laid-Open Nos. 62-142849 and 63-90738, in which diagnostic data from each section of a motor vehicle is updated and stored in a memory where the contents are stored at specified intervals even when the power supply is shut down; updating of the contents of the memory being inhibited (frozen) after a malfunction of an installed instrument is detected, so that diagnostic data at the time the malfunction is detected will be stored and the cause of the malfunction can be determined accurately after getting out of the motor vehicle.

Not all malfunctions of the installed instruments in a motor vehicle have the same priority. For example, since malfunctions such as a misfire in the engine, a malfunction of the fuel system and the like are serious malfunctions, such malfunctions have a higher priority than those of other malfunctions. Therefore, even if other malfunctions having respectively lower priorities occur earlier, when a malfunction having a higher priority occurs, thereafter, diagnostic data obtained at that time must be held in precedence over other data.

However, in the above-described conventional apparatus, when diagnostic data is frozen once when a malfunction of the apparatus occurs, such diagnostic data is not updated even when a malfunction having a priority higher than that of the above one occurs thereafter.

Therefore, when a malfunction having a high priority is detected, it is conceivable that the diagnostic data is replaced forcibly. However, if an ignition switch is turned off while this data is being replaced, a portion of the data which has not yet been replaced remains in a part of the memory and, on the contrary, erroneous diagnostic data is given, which is problematical. It is conceivable that a main relay for supplying power for some time after the ignition switch has been turned off is provided, however, such construction results in the hardware becoming overly complex.

The present invention solves the above-described problems of the prior art. It is an object of the present invention to provide a self-diagnosing apparatus for motor vehicles which is capable of reliably storing diagnostic data on high priority malfunctions.

## Disclosure of the Invention

The construction of the present invention will be explained with reference to Fig. 10. The present invention comprises diagnostic data detecting means for detecting diagnostic data necessary for analyzing malfunctions of instruments installed in a motor vehicle; storing means for storing a plurality of storage areas disposed so as to respectively correspond to priorities of the malfunctions of the instruments installed in a motor vehicle so that diagnostic data detected by the data detecting means is updated and stored as desired for each of the storage areas, and the stored contents thereof are held even when the ignition switch is in a turned off state; malfunction detecting means for detecting malfunctions of the instruments installed in the motor vehicle; inhibiting means for inhibiting the updating and storing of the diagnostic data corresponding to the priority of the malfunction in the storage area of the storing means; and diagnostic data output means for outputting the contents of the storing means from the storage areas respectively corresponding to priorities of the malfunctions.

In the above-described construction, storage areas, the number of which corresponds to the number of the priorities of the instrument malfunctions, are disposed. Therefore, even if an instrument malfunction with a low priority is detected and diagnostic data relating to this malfunction is frozen, since diagnostic data of the storing means corresponding to the instrument malfunction with a high priority is not frozen, the updating of the diagnostic data relating to the malfunction with a low priority is continued. When, thereafter, an instrument malfunction with a high priority is detected, diagnostic data relating to this malfunction is frozen and held.

Since an operation for replacing diagnostic data on an instrument malfunction having a high priority with diagnostic data on an instrument malfunction having a low priority is unnecessary, no problem, for example, one in which diagnostic data on an instrument malfunction having a low priority remains in a portion of the diagnostic data as a result of an ignition switch being turned off during the above replacing operation, occurs.

As described above, according to the self-diagnosing apparatus of the present invention, it is possible to reliably store diagnostic data for analyzing a serious instrument malfunction with a high priority.

#### Brief Description of the Drawings

Fig. 1 is an illustration of the entire construction of the self-diagnosing apparatus;  
 Fig. 2 is a block diagram of the control unit;  
 Fig. 3 is a program flowchart;  
 Fig. 4 is a program flowchart;  
 Fig. 5 is a program flowchart;  
 Fig. 6 is a program flowchart;  
 Fig. 7 is an illustration of the memory configuration;  
 Fig. 8 is a program flowchart;  
 Fig. 9 is a program flowchart; and  
 Fig. 10 is a conceptual block diagram of the construction of the present invention.

#### Best Mode for Carrying Out the Invention

In Figs. 1 and 2, a potentiometer 21 of a flow meter 31, an intake-air temperature sensor 24, a throttle sensor 27 of a throttle valve 32, and a fuel discharge valve 29 are disposed in the upstream portion of an intake-air pipe E1 of an engine E. A water temperature sensor 23 is disposed in a water jacket of the engine E, and an O2 sensor 22 is disposed in a discharge pipe E2 of the engine E.

A control unit 1 having a CPU 101 contained therein is disposed, and the CPU 101 is connected via a data bus to a RAM 102, a ROM 103, an oscillation circuit 104, input/output ports 105A and 105B, and output ports 106A, 106B, and 106C. The RAM 102 is separated into a common RAM for temporary storage and a standby RAM in which the contents at the time the ignition key is turned off are held.

Output signals from the potentiometer 21, the O2 sensor 22, the water temperature sensor 23, the intake-air temperature sensor 24 and the throttle sensor 27 are input through a multiplexer 107 and an A/D converter 108 to the input/output port 105A. Output signals from a cylinder determination sensor 25 and a rotational angle sensor 26 are input through a waveform shaping circuit 109 to the

input/output port 105B.

The output signals are supplied via output ports 106B and 106C to an igniter 28 and the fuel discharge valve 29.

5 When a malfunction of each of the above-mentioned instrument installed in a motor vehicle is detected by a sequence to be described later, an output signal is issued to a malfunction warning means 5 through the output port 106A and a drive circuit 112A. As will be described later, diagnostic data necessary for analyzing instrument malfunctions are exchanged via the input/output port 105B and an intercommunication circuit 110 with a fault diagnosing apparatus 4.

10 Fig. 3 shows a program for detecting a misfire malfunction. The program is activated at intervals of 30° crank angles (CA). When TDC is confirmed in step (hereinafter referred to as S) 101, the amount  $\Delta NE$  (TDC) of variations in the number of rotations of the engine for the duration of 60° CA up to TDC is calculated in S102. Next, BTDC 60° is confirmed in S103. In S104, the amount  $\Delta NE$  (BT60) of the fluctuation of the engine speed for the duration of 60° CA up to the present time is calculated.

15 In S105, the difference between  $\Delta NE$  (TDC) and  $\Delta NE$  (BT60) is calculated. When this difference exceeds 100 rpm, it is assumed that a misfire has occurred (S106), and a fail flag in the common RAM is set (S107).

20 Fig. 4 shows a program for detecting a malfunction of the fuel system. The program is activated at intervals of every 65 ms. A check is made in S201 and S202 to determine whether a FAF has reached an upper limit and a lower limit, respectively. In the above, FAF is an air-fuel ratio correction coefficient which can be obtained by integrating or skipping an output from the O2 sensor. When the state in which FAF is at the upper limit or lower limit continues for 10 s or more (S203), it is assumed that a malfunction has occurred in the fuel system, and the fail flag in the common RAM is set. In a case other than the above, the fail flag is cleared (S205).

25 Fig. 5 shows a program for detecting a malfunction of the throttle sensor 27. In S301, a check is made to determine whether a throttle opening signal is in the range from 0.1 V to 4.9 V (S301, S302). If the signal is in this range, the fail counter is cleared, and the fail flag in the common RAM is cleared (S305, S306). If, on the other hand, the time during which the signal is not present in the above-mentioned range exceeds 500 ms (S303), it is assumed that the throttle sensor has a malfunction, and the fail flag is set (S304).

30 Fig. 6 shows a program for inputting into the standby RAM the fact that the above-mentioned fail flags are set, which program is activated at inter-

vals of every 65 ms. In S401, a check is made to determine whether writing in the standby RAM is possible. When the fail flag has been set, predetermined bits of the standby RAM are set (S402, S403), so that the fact that a specific instrument malfunctions has been detected is stored.

The diagnostic data storage areas of the standby RAM are shown in Fig. 7. Frame 1 starting at address 10 is allocated as an area for storing various diagnostic data necessary for analyzing a high priority misfire and a high priority fuel system malfunction. Frame 2 starting at address 20 is allocated as an area for storing various diagnostic data necessary for analyzing malfunctions having lower priority than the above misfire malfunction. A malfunction code indicating the type of the malfunction is set at the beginning address of each frame as described later.

Fig. 8 shows a program for controlling writing in the standby RAM. The program is activated at intervals of every 65 ms. In S401, a check is made to determine whether the malfunction code has been set in frame 1. If the code has not been set, the diagnostic data stored in the previous cycle is updated into the newly input diagnostic data (S402). When the malfunction code has been set, updating is inhibited, and the diagnostic data is frozen.

In S403, a check is made to determine whether the malfunction code of frame 2 has been set. If the code has not been set, the diagnostic data is updated (S404); if it has been set, the diagnostic data is not updated. In S405 and S406, a check is made for a misfire malfunction and a fuel system malfunction, respectively. If either of these malfunctions is confirmed, the malfunction code of frame 1 is set, so that the diagnostic data is frozen. If the malfunction is one other than one of the two above-described malfunctions, the malfunction code of frame 2 is set, so that the diagnostic data is frozen.

Fig. 9 shows a program for connecting a fault diagnosing apparatus after getting out of the motor vehicle and transmitting diagnostic data, which program is activated every 16 ms. In S501, a check is made to determine if frozen diagnostic data has been requested from the diagnosing apparatus. If the request is for frame 1, it is confirmed that the data has been frozen, and diagnostic data of frame 1 for request PID is selected (S502, S503, S504). If the request is for frame 2, it is confirmed that the data has been frozen, and diagnostic data of frame 2 for the request PID is selected (S505, S506, S507). In the above case, the request PID is one in which diagnostic data is requested in an ID format from the diagnosing apparatus. For example, PID1 is the number of rotations of the engine, and PID2 is the speed of the motor vehicle.

5 The selected diagnostic data is transmitted to the diagnosing apparatus (S508). If the request is not for a data request for frame 1 in S502, it is confirmed in S505 that it is a request for frame 2, and diagnostic data for the request PID of frame 2 is transmitted to the diagnosing apparatus in S505, S506, and S507.

10 As described above, since priority is given to the malfunctions of the instrument installed in the motor vehicle, and since the frames, the number of which corresponds to the number of priorities, are secured in the standby RAM, even if a high priority malfunction is detected after a low priority malfunction is detected, diagnostic data necessary for analyzing the latter malfunction is secured instantly. Since it is not necessary to replace diagnostic data in such case, no problem, such as, for example, one in which completely different diagnostic data is stored in a part without being updated when the ignition switch is turned off while the diagnostic data is being replaced, occurs.

15 Although in the above-described embodiment two types of priorities are used, of course the number of frames may be expanded so that three or more types of priorities are included.

#### Industrial Applicability

20 The present invention can be used as an apparatus for supporting the analysis of the cause of the malfunction by a method in which diagnostic data, such as the operating state of the internal combustion engine or the running state of the motor vehicle when a malfunction occurs in the instrument installed in the motor vehicle, is stored so that the state when the malfunction occurred can be reproduced on the basis of the above-described stored diagnostic data when a repair is made after the malfunction of the motor vehicle has occurred.

#### Claims

1. A self-diagnosing apparatus for motor vehicles, comprising:  
45 diagnostic data detecting means for detecting diagnostic data necessary for analyzing malfunctions of instruments installed in a motor vehicle;  
50 storing means, in which a plurality of storage areas are disposed so as to respectively correspond to priorities of the malfunctions of said instruments installed in a motor vehicle so that diagnostic data detected by said data detecting means is updated and stored as desired for each of said storage areas, and the stored contents thereof are held even when the ignition switch is in a turned off state;  
55 malfunction detecting means for detecting

malfunctions of said instruments installed in the motor vehicle;

inhibiting means for inhibiting the updating and storing of the diagnostic data corresponding to the priority of the malfunction in said storage area of said storing means when the malfunctions of the instruments installed in the motor vehicle are detected by said malfunction detecting means; and

diagnostic data output means for outputting the stored contents of said storing means from said storage areas respectively corresponding to priorities of the malfunctions.

2. A self-diagnosing apparatus for motor vehicles according to claim 1, wherein said malfunction detecting means detects at least a fuel system malfunction of the internal combustion engine as a high priority malfunction.

3. A self-diagnosing apparatus for motor vehicles according to claim 1, wherein said malfunction detecting means detects at least a misfire malfunction of the internal combustion engine as a high priority malfunction.

4. A self-diagnosing apparatus for motor vehicles according to claim 1, wherein said storage areas for each priority of said storing means comprises a code storage area for storing a malfunction code indicating the type of the malfunction, and a plurality of data storage areas for storing said diagnostic data.

5. A self-diagnosing apparatus for motor vehicles according to claim 1, wherein said diagnostic data output means outputs diagnostic data to a fault diagnosing apparatus in distinction for each of said storage areas for each priority in response to a request from the fault diagnosing apparatus connected to the self-diagnosing apparatus installed in the motor vehicle.

6. A self-diagnosing apparatus for motor vehicles according to claim 1, wherein said diagnostic data output means outputs the stored contents of a high priority when a high priority malfunction has been detected when a request from the fault diagnosing apparatus connected to the self-diagnosing apparatus installed in a motor vehicle is one for a high priority malfunction, and outputs the stored contents of a low priority when a high priority malfunction has not been detected and a low priority malfunction has been detected.

7. A self-diagnosing apparatus for motor vehicles for detecting a malfunction of an instrument installed in a motor vehicle and storing the state of each section of the motor vehicle when the malfunction has occurred, comprising:

5 diagnostic data detecting means for detecting a plurality of diagnostic data necessary for analyzing the malfunction of the instrument installed in the motor vehicle;

10 first malfunction detecting means for detecting a high priority malfunction of said instruments installed in the motor vehicle;

15 first storing means for storing diagnostic data detected by said diagnostic data detecting means when the malfunction has occurred and the malfunction has been detected by said first malfunction detecting means, and for holding the stored contents even if the ignition switch of the motor vehicle is in a turned off state;

20 second malfunction detecting means for detecting a low priority malfunction of said instruments installed in the motor vehicle;

25 second storing means for storing diagnostic data detected by said diagnostic data detecting means when the malfunction has occurred and the malfunction has been detected by said second malfunction detecting means, and for holding the stored contents even if the ignition switch of the motor vehicle is in a turned off state; and

30 diagnostic data output means for outputting the stored contents of said first and second storing means.

35 8. A self-diagnosing apparatus for motor vehicles according to claim 7, wherein said first malfunction detecting means detects at least a fuel system malfunction of the internal combustion engine as a high priority malfunction.

40 9. A self-diagnosing apparatus for motor vehicles according to claim 7, wherein said first malfunction detecting means detects at least a misfire malfunction of the internal combustion engine as a high priority malfunction.

45 10. A self-diagnosing apparatus for motor vehicles according to claim 7, wherein said first and second storing means are formed separately in the storage areas within the same storage element.

50 11. A self-diagnosing apparatus for motor vehicles according to claim 7, wherein said first and second storing means comprises a code storage area for storing a malfunction code indicating the type of the malfunction, and a plurality of data storage areas for storing said diagnostic data.

12. A self-diagnosing apparatus for motor vehicles according to claim 7, wherein said diagnostic data output means outputs diagnostic data to a fault diagnosing apparatus with the stored contents of said first and second storage areas distinguished one from the other in response to a request from the fault diagnosing apparatus connected to the self-diagnosing apparatus installed in the motor vehicle. 5

13. A self-diagnosing apparatus for motor vehicles according to claim 7, wherein said diagnostic data output means outputs the stored contents of a high priority when a high priority malfunction has been detected when a request from the fault diagnosing apparatus connected to the self-diagnosing apparatus installed in a motor vehicle is one for a high priority malfunction, and outputs the stored contents of a low priority when a high priority malfunction has not been detected and a low priority malfunction has been detected. 10 15 20

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FIG.1

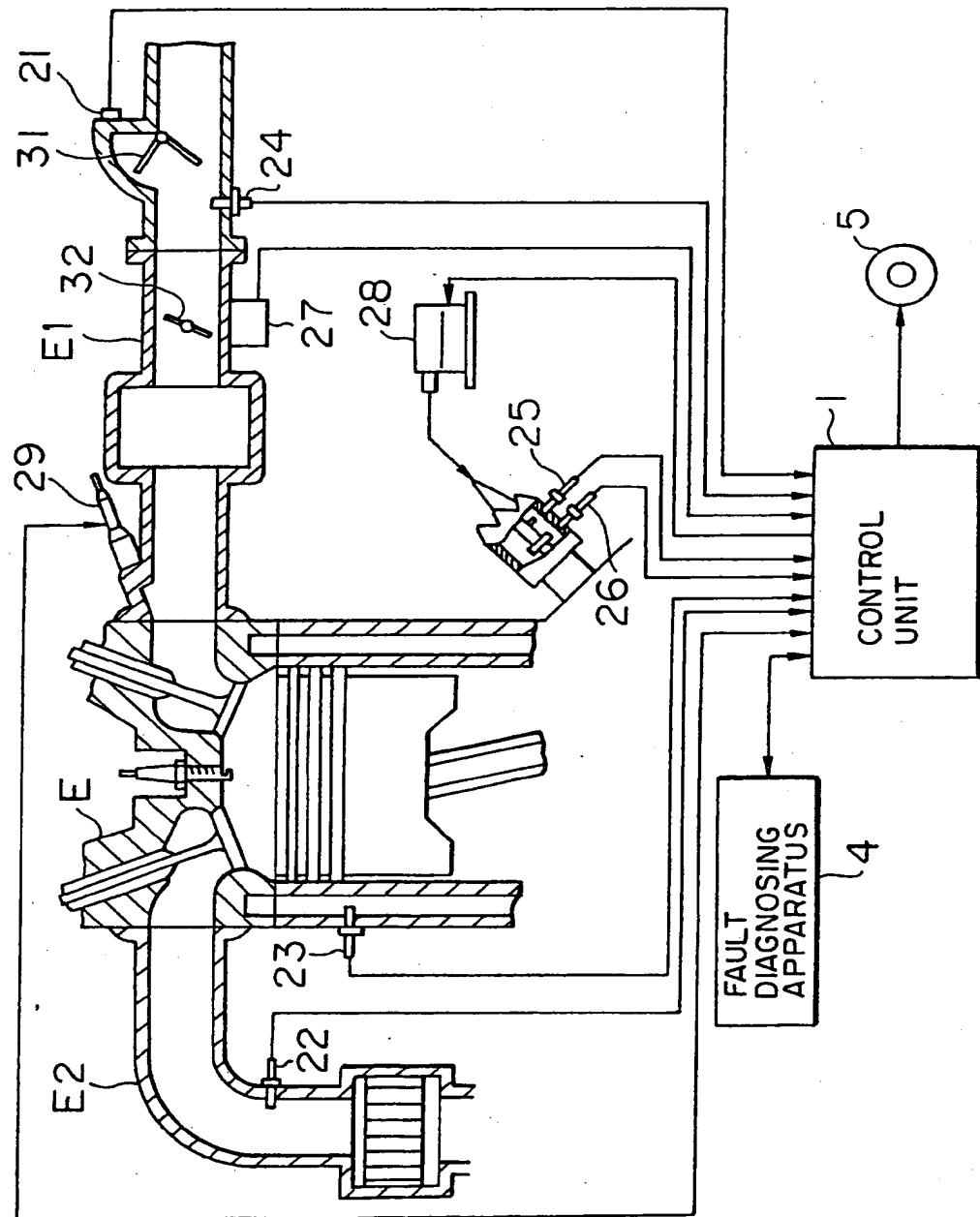


FIG. 2

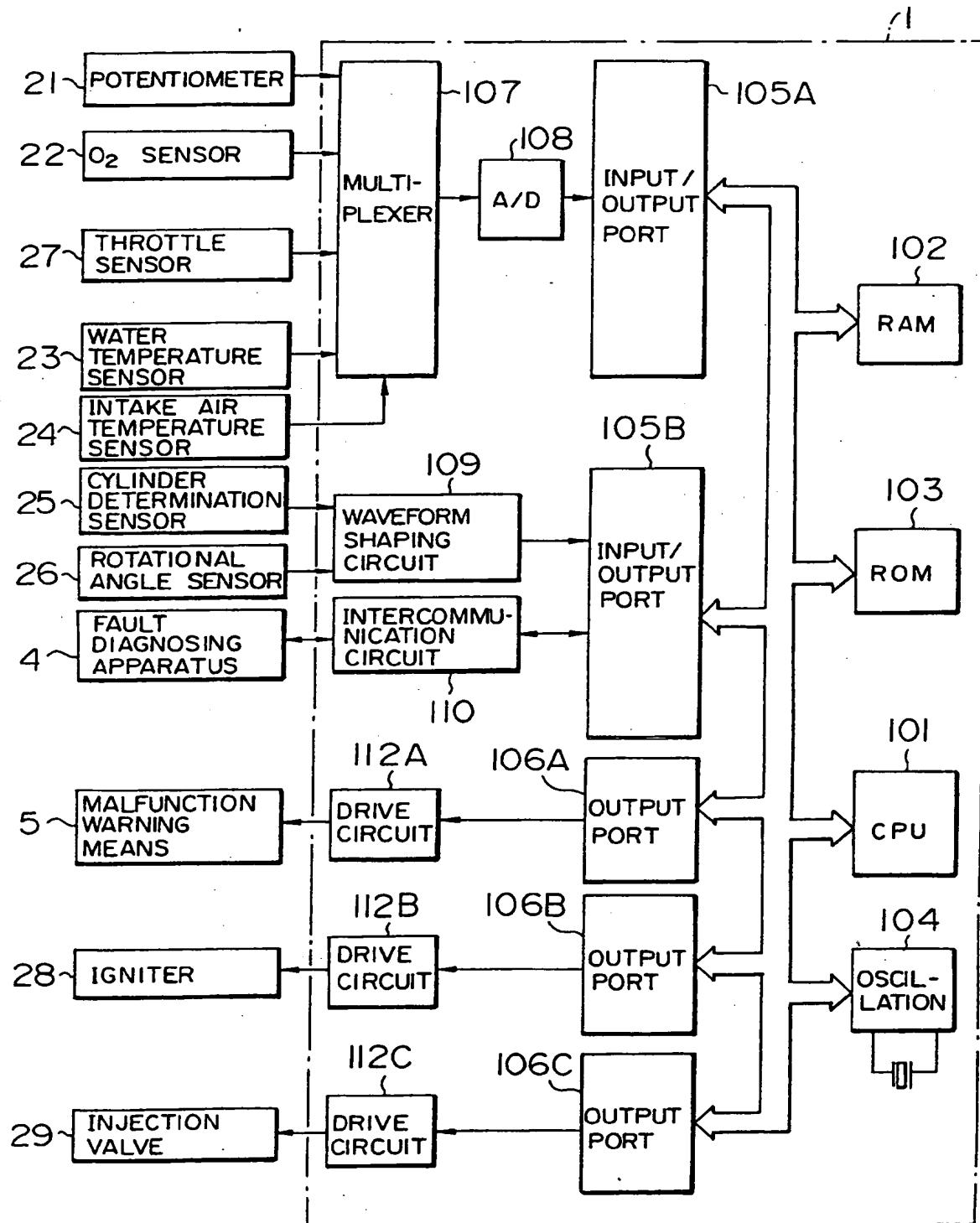


FIG. 3

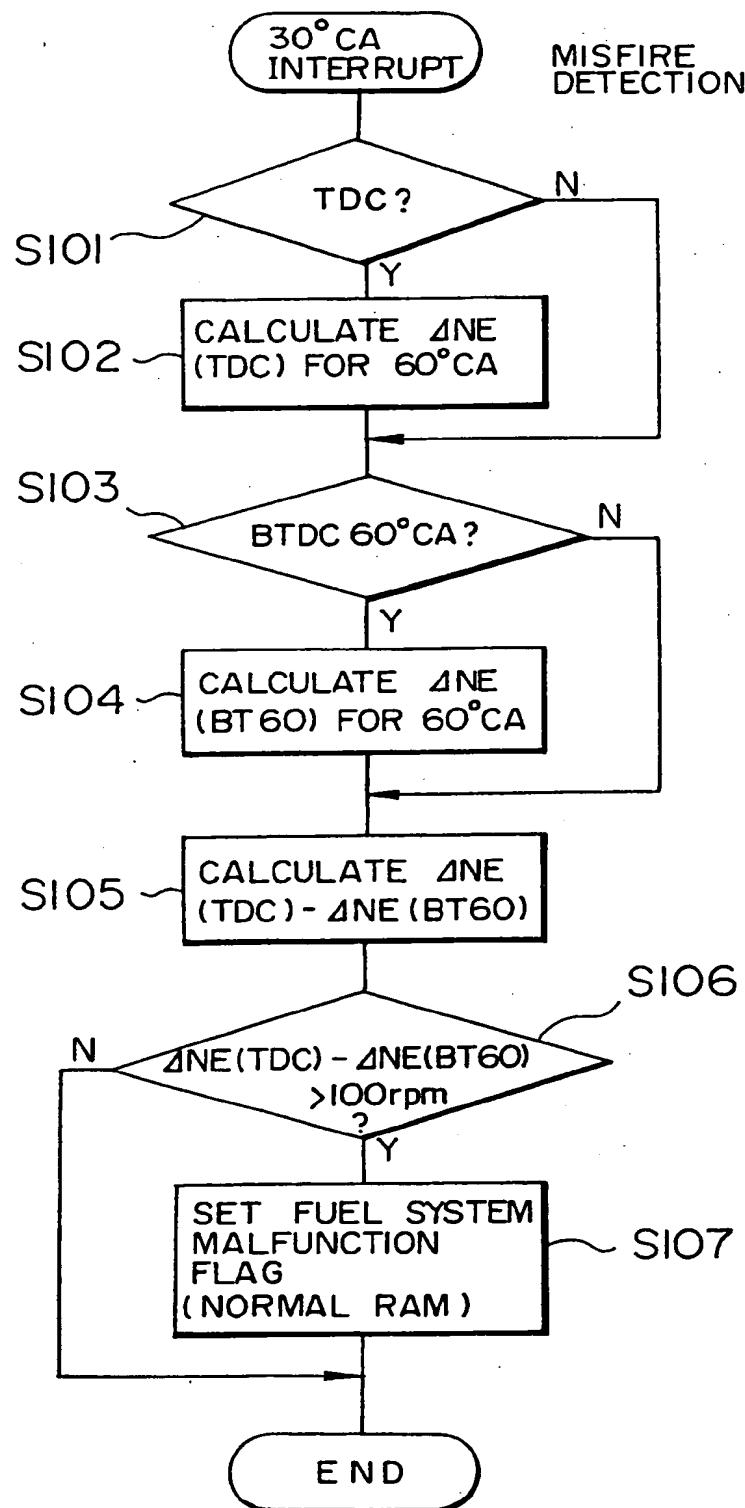


FIG. 4

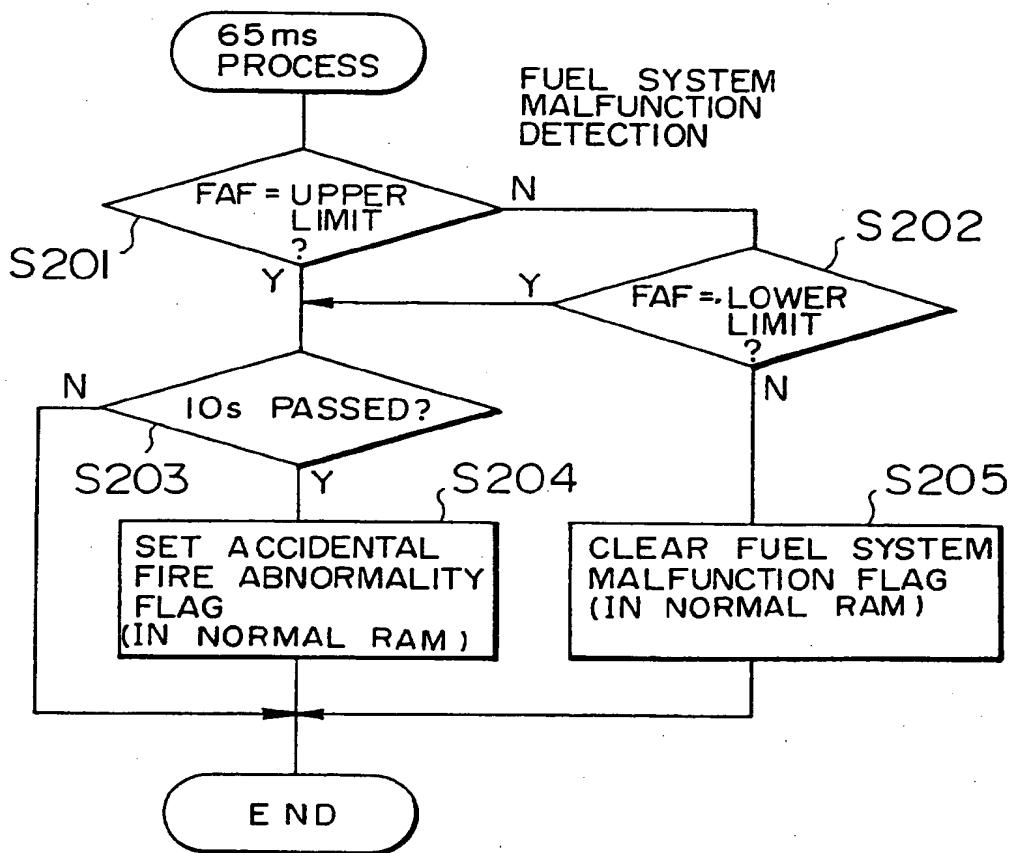


FIG. 5

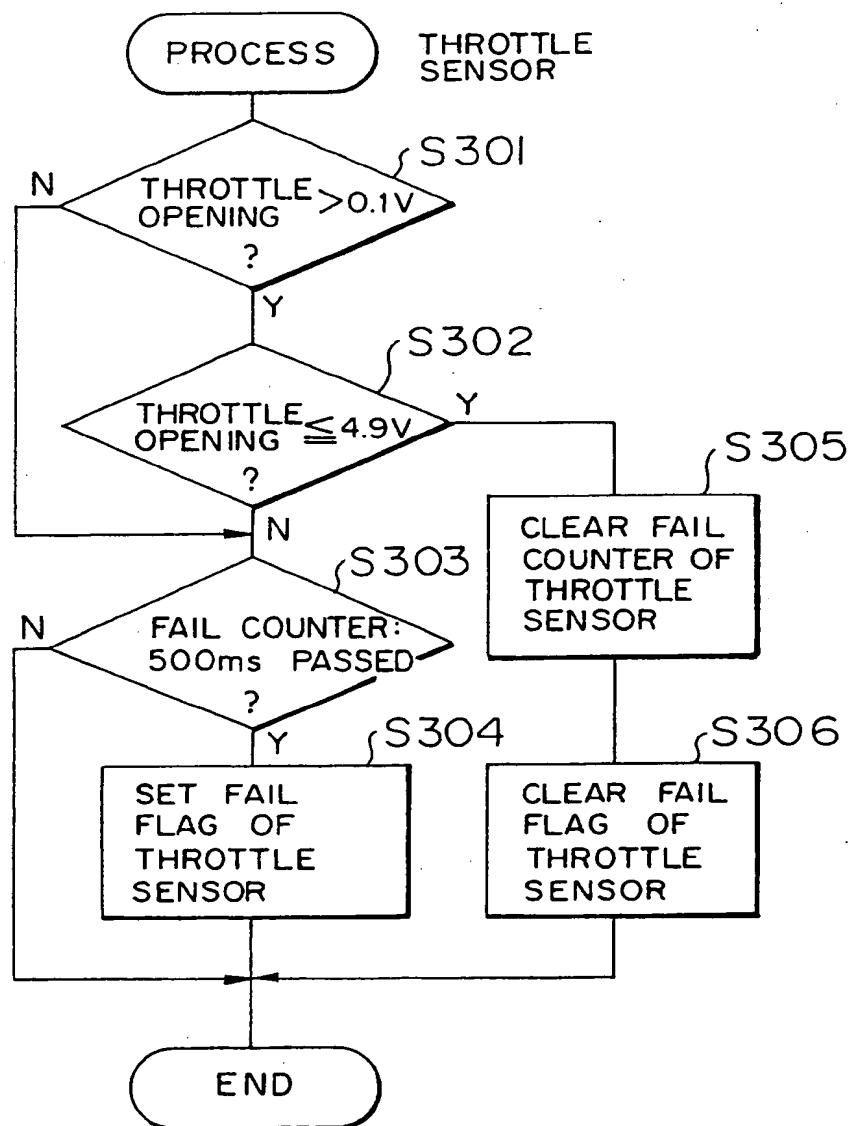
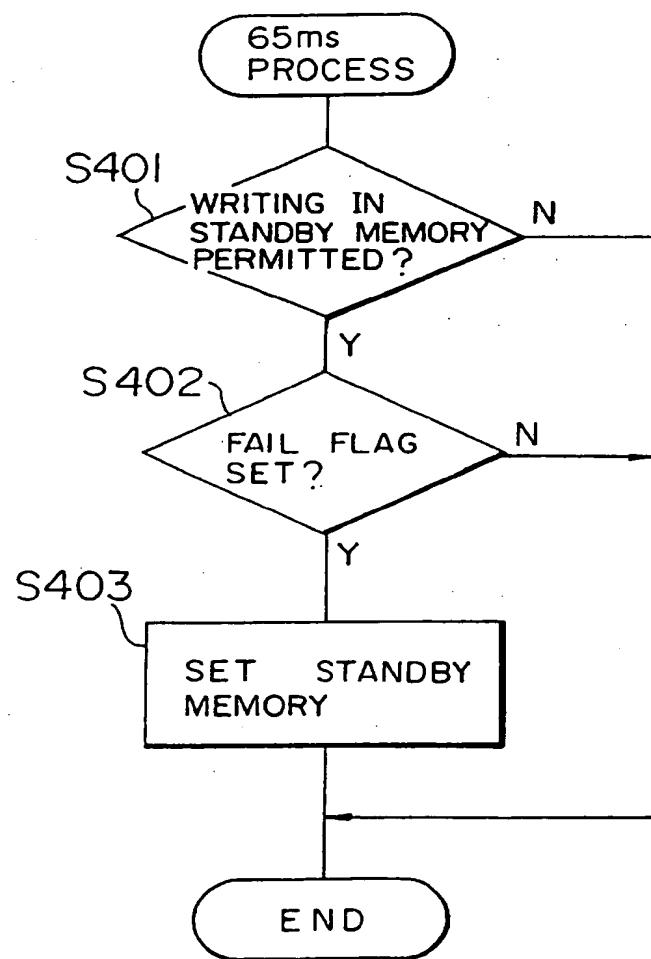


FIG. 6



## FIG. 7

RAM ADDRESS	FRAME 1		FRAME 2	
	10	11	20	21
10	MALFUNCTION CODE			
11	NUMBER OF ROTATIONS OF ENGINE			
12	WATER TEMPERATURE OF ENGINE			
13	THROTTLE OPENING			
14	RATE OF FLUCTUATION OF ENGINE SPEED			
15	NUMBER OF IGNITIONS DURING TRIP			
16	NUMBER OF MISFIRES DURING TRIP			
17	AIR - FUEL RATIO LEARNING VALUE			
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FIG. 8

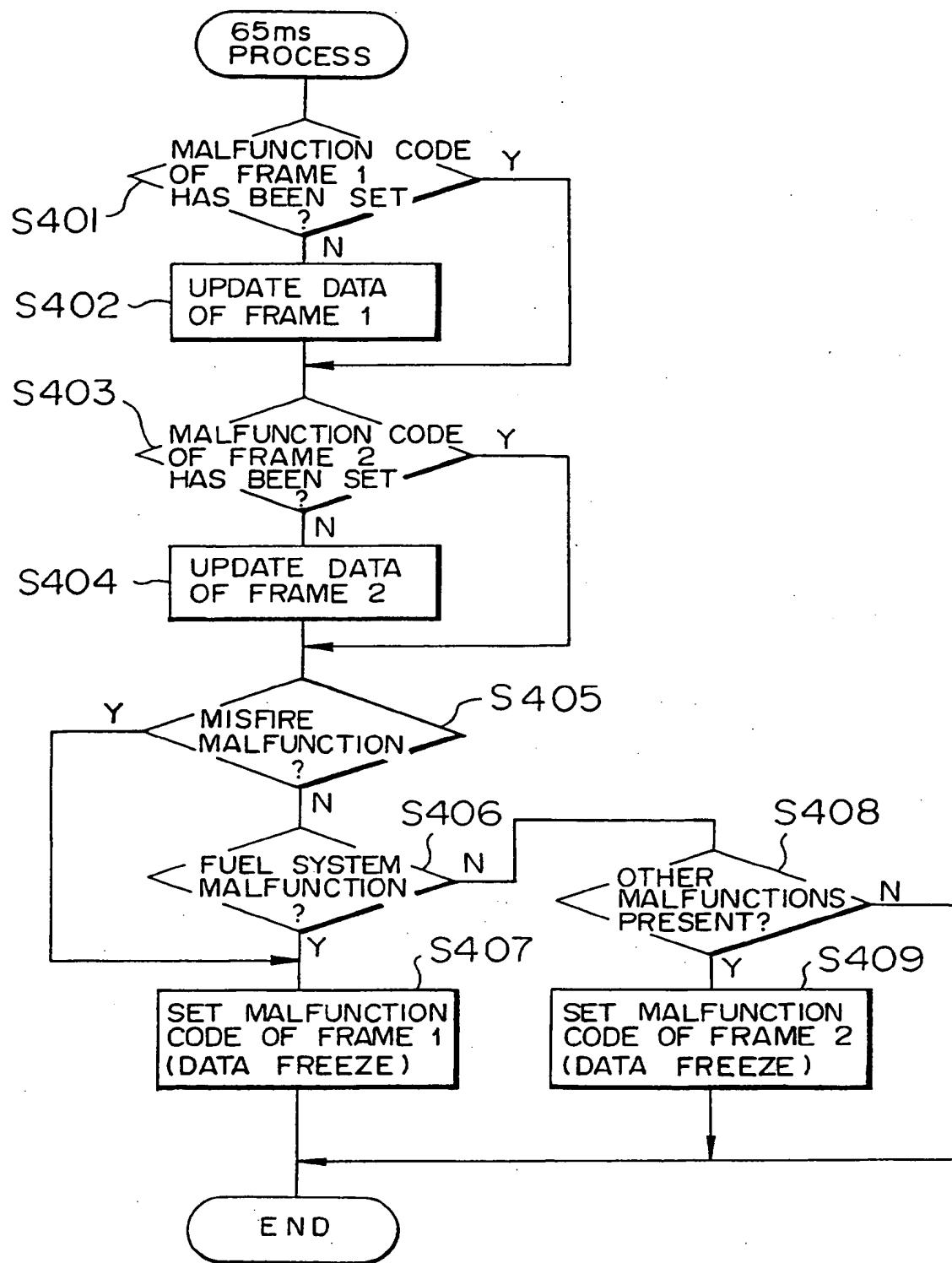


FIG. 9

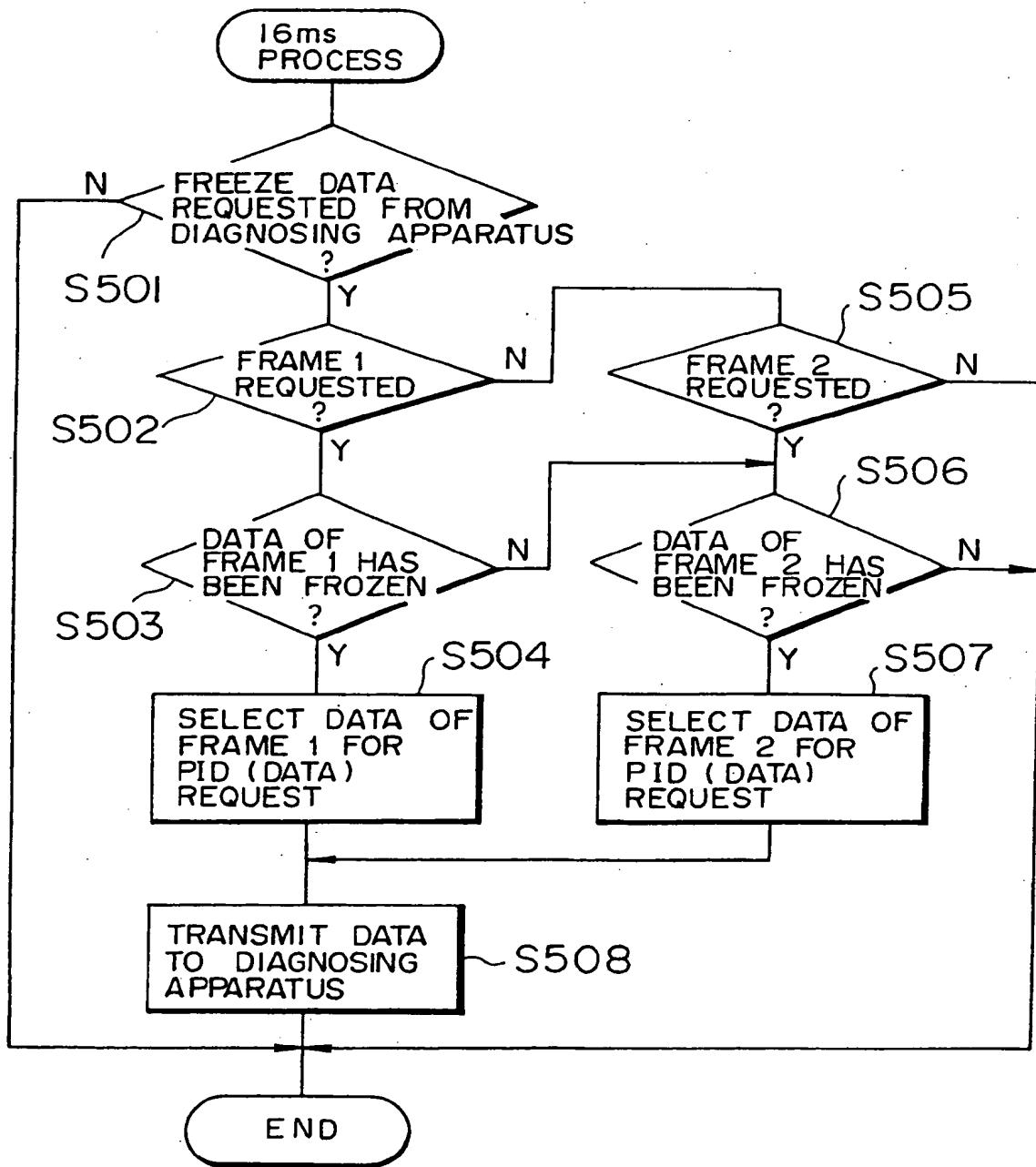
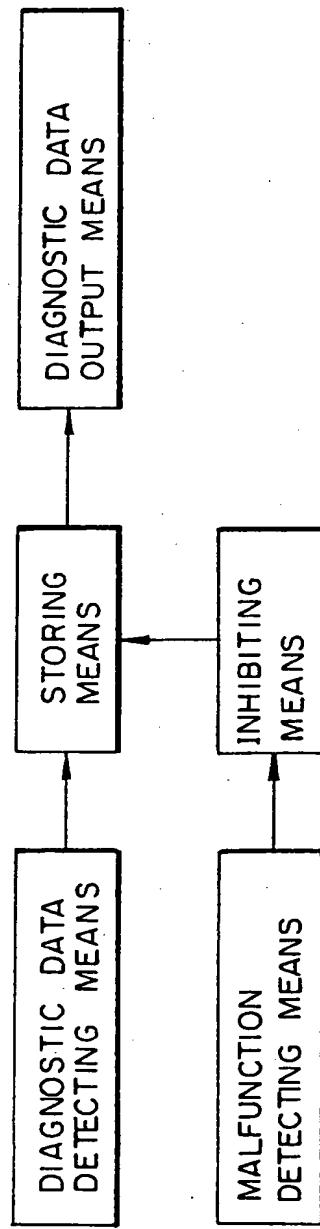


FIG. 10



## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/JP93/01025

A. CLASSIFICATION OF SUBJECT MATTER		
Int. Cl <sup>5</sup> F02D45/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
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Minimum documentation searched (classification system followed by classification symbols)		
Int. Cl <sup>5</sup> F02D45/00		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Jitsuyo Shinan Koho 1983 - 1993 Kokai Jitsuyo Shinan Koho 1971 - 1993		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, A, 62-3312 (Sawafuji Denki K.K., Hino Motors, Ltd.), January 9, 1987 (09. 01. 87), (Family: none)	1, 10
A	JP, A, 57-86544 (Hitachi, Ltd.), May 29, 1982 (29. 05. 82), Fig. 8 (Family: none)	4, 11
<input type="checkbox"/> Further documents are listed in the continuation of Box C.		<input type="checkbox"/> See patent family annex.
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Date of the actual completion of the international search October 12, 1993 (12. 10. 93)		Date of mailing of the international search report November 2, 1993 (02. 11. 93)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.		Authorized officer Telephone No.